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International monetary policy spillovers to emerging economies in Sub-Saharan Africa: A global VAR analysis ☆

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ABSTRACT

In this paper, we trace the transmission of monetary policy shocks from three prominent sources of global financial and trade shocks (US, Europe, and China) to the two largest emerging economies in Sub-Saharan Africa (SSA) (Nigeria and South Africa). To pursue this study's objective, we employ Global Vector Autoregression (GVAR) model and update the common GVAR database to accommodate selected SSA countries. We report impulse response functions obtained from the model to analyse the responses of inflation, exchange rate, interest rate, and output in the emerging SSA economies to monetary policy shocks emanating from the large open economies. We document some new findings on the relationship between international monetary policy and the behaviour of economic factors in the emerging SSA countries. First, we show that tight monetary policy in the US and EU moderates prices in Nigeria while it is inflationary in South Africa. Second, the impact of the same policy shock is positive and prolonged on the Nigerian Naira and South African Rand. Third, the monetary policy decisions in China and the US have greater influence on the monetary policy in Nigeria and South Africa compared to similar policy decisions in the EU.

Introduction

This study underscores the increasing diffusion of global macroeconomic shocks amongst countries due to rising financial globalisation and integration to explore the susceptibility of emerging economies to shocks from large open economies (see [6,37,39]). The focus on emerging economies lies in their vulnerability to the monetary policy shocks emanating from large open economies like the Euro Area, the United States, and China, given the trade interdependencies and ties involving international capital flows, debts, and financial aid between the two groups of countries (see [6,16]). This argument is specifically motivated for the two top emerging economies in the Sub-Saharan Africa (SSA)[1] namely, Nigeria and South Africa. These

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[1] The SSA have been previously shown to be highly vulnerable to external shock spillovers (see [11]).

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countries are the most financially linked with the global financial system in the region (see [24,30]).[2] Consequently, there are investment and policy considerations for our choice of the analysis of monetary policy shock spillovers. From the policy perspective, the spillover effects of the global monetary policy shocks, if not properly understood and effectively managed could pose difficulties to the domestic policy design in emerging economies as it is capable of disrupting capital flows (see [16]) and modifying the degree to which financial frictions tighten or relax (see [13]). From the investment standpoint, foreign investors should be interested to know how such risks affect their investments as they seek diversification in emerging economies.

The study of international monetary policy shock transmission to emerging countries is not new. The literature shows that these shocks are transmitted to these economies through some well-known financial and trade channels that include interest rate (see, for example, [12,26,27]), exchange rate (see [29]), domestic credit (see [19,21]), and asset prices (see [22]). In the present study, we trace the sources of the international monetary policy shocks in the emerging economies of SSA to the US, the Euro Area, and China. This is similar to the previous studies on the international monetary policy spillovers from developed to emerging markets such as Sun et al. [39], Inoue et al. [18], Chen et al. [6], Hajek and Horvath [15], Antonakakis et al. [2], Dées and Galesi [10], Sikiru and Salisu [37], Ter Ellen et al. [40], Walerych and Wesołowski [41], Cavaca, and Meurer [5], amongst others. The Euro Area and the US are found to be the dominant transmitters of international monetary policy spillovers to many countries [2] while there is also evidence suggesting that China is another monetary policy shock transmitter in the world. This further justifies the consideration of the US, Euro Area and China as monetary policy shock transmitters to emerging economies in SSA.

Meanwhile, varied empirical relationships have been expressed by the previous studies between international monetary policy and economic behaviour of smaller open economies. For example, monetary policy shock spillovers from the US are observed to be partly responsible for policy overheating in some emerging economies [6] likewise the spillovers from the European Central Bank's (ECB) monetary policy shocks seem to impose challenges on the domestic monetary policy effectiveness of emerging countries in the non-Euro area [39]. However, an expansionary US monetary policy shock contributes to the emergence of a Global Financial Cycle, which boosts macroeconomic activity worldwide [10]. In addition, while Walerych and Wesołowski [41] show evidence that international spillovers of both Fed and ECB conventional monetary policies to Emerging Market Economies (EMEs) are global, Hajek and Horvath [15] note that the magnitude of the effect of international monetary policy shocks differs across countries. Other studies such as Barbosa et al. [3], Gajewski et al. [13], Ter Ellen et al. [40] and Cavaca and Meurer [5] also find evidence of international monetary policy spillovers from US and Europe to the macroecnomic behaviour of smaller open economies. Despite African countries, particularly Nigeria and South Africa, are experiencing rising level of financial globalization, no study has investigated the responses of the African economies to changes in international monetary policy, to the best of our knowledge. The only notable study by Sikiru and Salisu [37] deals with one sub-region (West Africa) of SSA and therefore may limit the implications of the outcome to the sub-region considered.

The Global Vector Autoregressive (GVAR) model developed by Pesaran et al. [34] and further extended by Dees et al. [9] and Chudik and Smith [8] fits well for the contribution of this study, which is to examine the impact of cross-country monetary policy shocks transmission.[3] Compared to the conventional VAR model, the GVAR allows for the analysis of the responses of the macroeconomic indicators of an economy to various economic shocks (including real and monetary/financial shocks, trade shocks amongst others) emanating from not only within the economy but also the regional and global shocks.[4] Hence, we update the GVAR baseline database by Pesaran et al. [34] to include the emerging economies in SSA. In the end, we report notable findings that strengthen the literature on the susceptibility of emerging economies to global shocks; with particular reference to Nigeria and South Africa as the major investment hubs in Africa. More significantly, we deduce that the monetary policy decisions by the US and China have greater influence on the domestic monetary policy decisions of the emerging countries under investigation than the monetary policy decisions by Europe.

Theory and methodology

The economic intuition for international monetary policy shock

In this section, we first tease out the standard interest rate-based channel for domestic monetary policy transmission, and thereafter, we highlight how actions of monetary policy authority in a foreign country could impact the transmission of monetary policy in a domestic economy. The model in this study hinges on the interest rate channel of the monetary policy transmission mechanism. This channel describes how policy-induced changes in the nominal money stock or short-term nominal interest rate impact the real variables such as aggregate output, inflation, and employment [31]. The traditional

[2] Nigeria and South Africa are the two largest economies in Africa. The two countries account for about 50 percent of the FDI inflows to the region and 80 percent the region's GDP (see [14]).

[3] Some of the attractions to GVAR model are well documented in Pesaran et al. [34], Chudik and Smith [8], Sun et al. [39], among others.

[4] The GVAR model was originally introduced in the seminal paper by Pesaran et al. [34] as a pragmatic approach to building a coherent global model of the world economy that takes into account the inter-linkages of the global economy.

Keynesian view on the transmission of monetary tightening to the real economy is characterized schematically as follows:[5]

$$M\downarrow \ \Rightarrow i\uparrow \ \Rightarrow I\downarrow \ \Rightarrow Y\downarrow$$

where contractionary monetary policy ($M\downarrow$) leads to an increase in real interest rates ($i\uparrow$), raises the cost of capital, and in turn causes a reduction in investment spending ($I\downarrow$), thereby resulting in a decline in aggregate demand and drop in output ($Y\downarrow$). Expansionary monetary policy ($M\uparrow$), on the other hand, could be affected by central banks through a reduction in the policy rate. This affects the level of liquidity in the economy, stimulates investment ($I\uparrow$) and consumption of durable goods through a reduction in long-term real interest rates ($i\downarrow$) (see [23]). The corresponding shift in aggregate demand is reflected in an increase in aggregate output ($Y\uparrow$) and prices.

The foregoing explains a typical transmission for domestic monetary policy shock. What has remained ambiguous in the literature however is how international monetary policy shock is transmitted. For instance, does a monetary expansion in the US, Europe, and China lead to recessions or booms in emerging economies? Does monetary expansion improve or worsen exchange rate behaviour, price stability, and growth trends in these economies? These questions are gradually gaining prominence in the literature (see [2,13]).

Two principal channels have been identified in the literature: the exchange rate channel and the interest rate channel [20]. A surprise decrease in the interest rate of a foreign country (say the US) could lead to monetary expansion and by extension an improvement in trade balance via real exchange rate depreciation relative to the currency of a domestic economy (say Nigeria). On this channel, it is assumed that monetary policy authority in the domestic economy will not take any action in the short run, hence, its macro-economy responds to the international monetary policy shock via the exchange rate channel.[6] The interest rate channel of international monetary policy spillover assumes that a surprise increase in the interest rate of a foreign country may lead to a rise in domestic interest rate via the monetary policy rate which is correspondingly raised by the domestic monetary policy authority to prevent capital flight. Evidence from Kim [20] suggests that the exchange rate channel plays a minor role while the interest rate channel is more important.

The GVAR model

The global vector autoregression (GVAR) model has become prominent in the exploration of the various channels on interconnectedness and transmission of shocks across international borders. The theoretical benefits of the framework over traditional multivariate models such as restricted and unrestricted VAR, Panel VAR, and Structural VAR as well as their empirical applications, have been widely discussed in the literature (see [9,34,35]). The GVAR simultaneously models a large number of countries and accounts for a broad set of domestic, foreign, and global variables, which would be impracticable with traditional multivariate models due to parameter proliferation (see [25]).[7] The GVAR model typically involves two steps. The first step requires setting up individual VAR models for the cross-sectional units of the panel of countries in the GVAR database. As each VAR model includes domestic endogenous variables augmented with weakly exogenous foreign and global variables, it can be appropriately defined as VARX*. Thus, it is the VARX* that is estimated for each cross-sectional unit. The second stage involves stacking all the individual VARX models using weighted matrices.

To proceed, we assume a global economy with N economies indexed by $i = 1, ..., N$, each featuring k_i variables observed during the time periods $t = 1, 2, \ldots, T$. Specifically, we construct a four-variable VAR model for the individual economies; $x_t' = [\pi_t, y_t, r_t, e_t]'$ where π_t is consumer price (CPI) inflation computed as 100*log(CPI/CPI(−4)); y_t, the Gross Domestic Product in Purchasing Power Parity (GDP-PPP), is expressed in natural logs; r_t is short term nominal interest rate; and e_t is real exchange rate computed as log(Nominal Exchange Rate/CPI). The ordering of variables suggests that any international monetary policy shock will first impact the natural path of the exchange rate of the domestic economy and therefore the domestic monetary policy authority is expected to respond using its policy rate with attendant consequences on output and inflation. Thus, we assume that x_{it} is a $4_i \times 1$ vector of variables specific to cross-section (domestic) unit i in time period t, and x_{it}^* denote the corresponding $4_i^* \times 1$ vector of foreign variables which are typically constructed as:

$$x_{it}^* = \sum_{j=1}^{N} w_{ij} x_{jt} \tag{1}$$

where $\sum_{j=1}^{N} w_{ij} = 1$, and $w_{ii} = 0$. As originally proposed by Pesaran et al. [34], we represent VARX* model for this study as:

$$x_{it} = \sum_{\ell=1}^{p_i} \Phi_{i\ell} x_{i,t-\ell} + \Lambda_{i0} x_{it}^* + \sum_{\ell=1}^{q_i} \Lambda_{i\ell} x_{i,t-\ell}^* + \varepsilon_{it} \tag{2}$$

where $i = 1, 2, \ldots, N$, $\Phi_{i\ell}$, for $\ell = 1, 2, \ldots, p_i$, is a $4_i \times 4_i$ matrix of unknown parameters for domestic variables, $\Lambda_{i\ell}$, for $\ell = 0, 1, 2, \ldots, q_i$, is a $4_i^* \times 4_i^*$ matrix of unknown parameters for foreign variables and ε_{it} is a $4_i \times 1$ vector of errors. The lag

[5] See Mishkin [26] for technical details.

[6] This assumption is only valid for countries with flexible or managed-floating exchange rate regime.

[7] Marco [25]: Estimating GVAR weight matrices, Spatial Economic Analysis, DOI: 10.1080/17421772.2019.1556800

order for each country is selected using the Akaike Information Criterion (AIC). Equation (2) can be described as a VARX* model as it augments the traditional VAR with a vector of the foreign variables (i.e., x_{it}^{*}) and their lagged values. The foreign variables are usually treated as weakly exogenous in estimating the unknown parameters, which implies that no long-run feedback from the country-specific variables to foreign variables without necessarily ruling out lagged short-run feedback between the two sets of variables. This assumption has to be tested in the estimation process. Although, Pesaran et al. [34] did not provide a theoretical justification for the assumption of weak exogeneity, subsequent studies offer conditions under which the weak exogeneity assumption is met (see [7]). We can rewrite equation (2) in a more compact form as:

$$A_{i0}z_{it} = \sum_{\iota=1}^{p} A_{i\iota} z_{i,t-\iota} + \varepsilon_{it} \tag{3}$$

where $z_{it} = (x_{it}', x_{it}^{*'})'$ with $4_i + 4_i^{*}$ dimensional vector of domestic and country-specific foreign variables included in the sub-model of country i; $A_{i0} = (I_{k_i}, -\Lambda_{i0})$, $A_{i\iota} = (\Phi_{i\iota}, \Lambda_{i\iota})$ for $\iota = 1, 2, \ldots, p$; $p = \max_i(p_i, q_i)$. The GVAR model allows for inter-dependence through three channels as depicted in Eq. (3): (i) the contemporaneous interrelation of domestic variables with foreign-specific variables with their lagged values, (ii) the dependence of domestic variables on global variables and their associated lagged values, and (iii) the contemporaneous dependence of shocks across countries because of cross-country co-variances [32]. As a result, recent studies that have applied the GVAR framework results to the estimation of the individual VARXmodels in their error correction form with the weakly exogeneous components included in the cointegration equation to account for the long-run relationships between the domestic and foreign variables.

Following the estimation of the individual VARXfor all the countries, the corresponding estimates are related through link matrices defined by the respective weights for each country, and hence stacked together to build the GVAR model:

$$G_0 x_t = \alpha_0 + \alpha_1 t + G_1 x_{i,t-1} + \ldots + G_p x_{i,t-p} + u_t \tag{4}$$

where $x_t = (x_{0t}', x_{1t}', \ldots, x_{Nt}')'$ is a global vector of collection of all domestic endogenous variables with $k = \sum_{i=0}^{N} k_i$ a number of variables and G_0 is a non-singular matrix that depends on the weights and parameter estimates. Eq. (4) can be inverted by pre-multiplying it with the inverse of G_0 to obtain the reduced form as follows:

$$x_t = \beta_0 + \beta_1 t + \sum_{j=1}^{p} F_j x_{t-p} + e_t \tag{5}$$

where $\beta_0 = G_0^{-1}\alpha_0; \beta_1 = G_0^{-1}\alpha_1$; $F_j = G_0^{-1}G_j$, $j = 1, \ldots, p$ and $e_t = G_0^{-1}\varepsilon_t$. Eq. (5) can be solved recursively to obtain the generalized impulse response functions (GIRFs) and the forecast error variance decompositions (FEVDs). For the purpose of estimation, we update the existing GVAR database to include Nigeria which was hitherto excluded. The motivation for limiting our choice of emerging economies to the two largest economies in Sub-Saharan Africa has been rendered in Section 1.

Results and discussion

Data and preliminaries

The preliminary and empirical analyses in this study rely on the data in the GVAR toolbox, prepared by Smith and Galesi [38] from 1919Q2 to 2016Q4 and updated by Mohaddes and Raissi [28] to 2019Q4.[8] These consist of quarterly data of the logs of real equity prices, short and long-term interest rate, exchange rate, inflation rate, oil price, agricultural commodities, metals, amongst others, for 32 countries (both developed and emerging) and the US over the period 1979Q4–2019Q4. Notwithstanding the countries in the database for GVAR analysis, only the results of the countries of interest- Nigeria and South Africa, are discussed in this study and this is done with respect to their response to the three prominent sources of global financial and trade shocks involving the US, Europe, and China.

We begin with some preliminary analyses involving descriptive statistics and unit root tests (see the appendix). From the statistics (see Table SM1), it is evident that the recipient of shocks (Nigeria and South Africa) have higher inflation compared to that of the origin of shocks (the US, Europe, and China), with Nigeria having an average inflation of 11.6%, while South Africa is having an average inflation of 5.2% over the sample period. This may explain why the nominal interest rate of Nigeria (18.4%) is, on the average, higher than that of South Africa (11.5%) over the same period. The nominal interest rates of the three shock transmitting countries are less than 10%, with the US having 5.7%, China 3.5% and Europe 2.8%. The lower interest rate in these countries suggests potential outflow of investment to SSA from the US, China and Europe. The standard deviation of the Nigeria's real exchange rate (0.523) is higher than that of South Africa (0.240), suggesting that Nigeria's real exchange rate is more volatile. The US exchange rate is not captured since the US dollar is the reference currency. Meanwhile, the output of South Africa appears more volatile than that of Nigeria; with 0.345 standard deviation as compared to 0.336 in the case of Nigeria.

[8] The data is freely accessible at: http://www.econ.cam.ac.uk/people-files/emeritus/mhp1/GVAR/GVAR.html. Further details regarding the description of its compilation, revision and updates are discussed in Mohaddes and Raissi [28].

Table 1
Test of the null of parameter constancy.

Alternative test statistics		**y**	π	**e**	**r**
PK sup	Nigeria	0.60 (0.53)	0.68 (0.54)	0.91 (0.88)	0.31(0.52)
	South Africa	0.69 (1.02)	0.44 (0.68)	0.49 (1.00)	0.30(0.64)
PK	Nigeria	0.06 (0.05)	0.03 (0.05)	0.10 (0.21)	0.02(0.04)
msq	South Africa	0.15 (0.30)	0.03 (0.10)	0.04 (0.28)	0.02(0.09)
Nyblom	Nigeria	2.99 (3.07)	1.23 (2.93)	1.52 (3.18)	2.53(2.88)
	South Africa	1.92 (3.28)	2.44 (2.76)	1.54(2.71)	2.50(2.87)
Robust	Nigeria	3.38 (4.08)	3.22 (4.11)	3.49 (4.25)	2.85(4.04)
Nyblom	South Africa	2.67 (3.46)	2.62 (3.32)	1.97 (3.37)	3.34(3.31)
QLR	Nigeria	198.68 (57.74)	55.70 (56.25)	24.56 (135.29)	46.85(81.27)
	South Africa	46.92 (103.20)	43.46 (46.78)	34.02 (98.58)	80.40(59.42)
Robust	Nigeria	2779.49 (10,205.27)	84.01 (572.03)	49.07 (315.90)	132.12(1004.05)
QLR	South Africa	39.17 (133.21)	33.19 (407.22)	45.33 (224.98)	124.44(622.65)
MW	Nigeria	26.23 (24.61)	22.40 (25.90)	23.03 (28.73)	23.45(24.49)
	South Africa	40.98 (26.23)	11.99 (22.40)	10.87 (23.03)	19.86(23.45)
Robust	Nigeria	416.90 (1590.70)	34.51 (121.28)	23.60 (73.42)	43.67(195.49)
MW	South Africa	22.29 (30.14)	19.81 (40.78)	16.59 (34.44)	26.41(59.25)
APW	Nigeria	95.41 (25.25)	23.92 (24.68)	8.76 (63.71)	19.78(36.71)
	South Africa	20.36 (47.67)	19.35 (19.76)	13.91 (45.36)	37.34(26.07)
Robust	Nigeria	65,535.00 (65,535.00)	38.08	21.02 (154.02)	62.16(498.09)
APW	South Africa	16.75 (62.79)	13.03	18.74 (108.73)	58.29 (307.39)

Note: Values in parenthesis are the standard errors of the estimated parameters.

Table 2
Contemporaneous effects of foreign variables on their domestic counterparts.

Countries	**y**	π	**r**
NIGERIA	0.12	-1.29^{*}	-0.24^{***}
	[0.11]	[0.78]	[0.09]
	(1.09)	(−1.67)	(−2.56)
SOUTH	2.53^{***}	0.30	−0.02
AFRICA	[0.97]	[0.32]	[0.17]
	(2.60)	(0.94)	(−0.14)

Note: White heteroskedastic-robust Standard Errors and t-ratios are given in [] and () respectively. *, **, and *** represent significance at 10%, 5% and 1% level of significance respectively.

We also conduct unit root tests for all the three classes of variables in a typical GVAR model – the domestic, foreign, and global variables. This was conducted in respect of our selected countries, as a precondition for the model. The results are reported in Tables SM2, SM3, and SM4. Except for inflation, all the variables are integrated of order one. Hence, the rest of the variables are expressed in the same order as inflation for ease of estimation.

The stability of the GVAR model

We conduct the structural stability tests for the GVAR model using several parameter constancy tests as in Dees et al. [9]. The tests employed in our analysis are Ploberger and Kramer [36] maximal OLS cumulative sum (CUSUM) statistic, denoted by "PKsup" and its mean square variant "PKmsq". The PKsup statistic is similar to the CUSUM test suggested by Brown et al. [4], although the latter is based on recursive rather than OLS residuals. In addition, the test proposed by Nyblom [33], likelihood ratio statistic (QLR), mean Wald statistic (MW) of Hansen [17], Andrews and Ploberger [1], and Andrews and Ploberger [1] Wald statistic based on the exponential average (APW) are also included with their heteroskedasticity-robust versions. The results of the tests are presented in Table 1 by country and macroeconomic variable. At the 5% significance level, we fail to reject the null of structural stability which validates our assumption of fixed coefficients as against time-varying coefficients. In other words, our assumption of parameter constancy is validated regardless of the choice of structural stability test.

We present in Table 2 the contemporaneous effects of global variables on their domestic counterparts. For emerging economies considered in this paper, a 1% increase in global output growth in each quarter leads to a 0.12% increase in GDP for Nigeria and a 2.53% increase for South Africa. A 1% increase in global inflation leads to a decline in inflation in Nigeria by 1.29% and a 0.3% increase in South Africa. We also observe a significant inverse relationship between the domestic interest rate and foreign interest rate in Nigeria. In Table 3, we present results on the correlation of idiosyncratic shocks of the individual country models since a low correlation is an indication that the GVAR is successful at capturing the common effects driving the endogenous variables. Statistics in Table 3 show that cross-section correlations of real GDP growth and exchange rate are quite high - 93% and 94%, respectively, for Nigeria and South Africa. This suggests significant co-movement between output growth and exchange rate. For inflation rate, the cross-section correlations are low representing 8% and

Table 3
Average pair-wise cross-section correlations: variables and residuals.

Variables	Countries	Levels	First Differences	VECMX* Residuals
Y	Nigeria	0.93	0.03	−0.02
	South Africa	0.93	0.05	−0.01
π	Nigeria	0.08	0.10	0.02
	South Africa	0.16	0.16	0.01
e	Nigeria	0.94	0.16	0.03
	South Africa	0.94	0.27	0.13
r	Nigeria	0.35	−0.20	−0.01
	South Africa	0.52	0.20	0.00

Note: VECMX residuals are based on co-integrating VAR models with country-specific foreign variables.

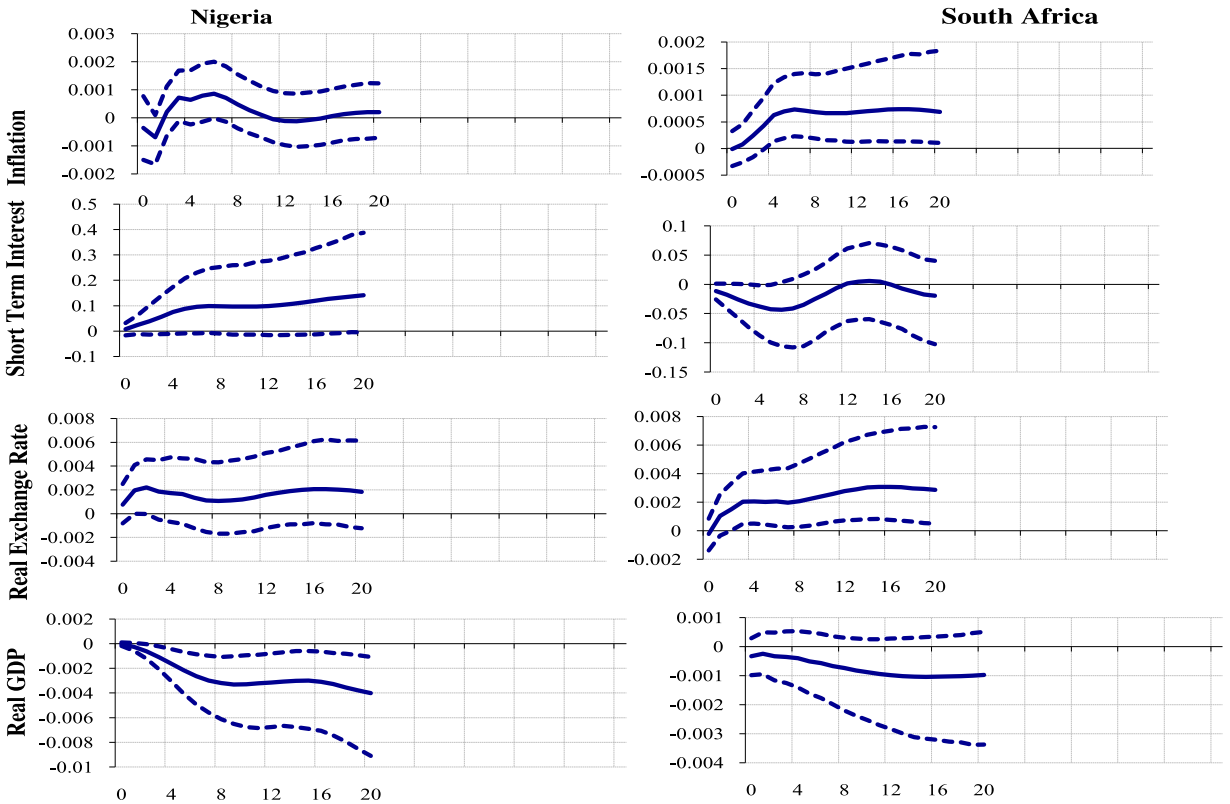

Fig. 1. Impulse responses of macroeconomic variables in Nigeria and South Africa to the US monetary policy shock.

16% for Nigeria and South Africa respectively and interest rate (35% and 52% , respectively). However, the cross-section correlation falls for real GDP growth and exchange rate as we move from level to first difference.

Dynamic analysis of monetary policy shocks from the US, EU, and China

The focus in this section is to examine the response of macroeconomic variables in emerging economies in Sub-Saharan Africa (Nigeria (NG) and South-Africa (SA)) to international monetary policy shocks. The results of the responses of the countries to US monetary policy shocks are presented in Fig. 1. The NG and SA respond differently to positive US monetary policy shock. The US monetary policy shock, which has an initial negative but temporary impact on NG's inflation, has a positive and permanent impact on inflation in SA. This supports evidence from Hajek and Horvath [15], which suggests that the effect of international monetary policy shocks differs across countries. The NG's (SA's) short-term interest rate responds positively (negatively) to the US monetary policy shock and the effect of the shock dies out with time. The response of the real exchange rate to US monetary policy shock is positive for NG and SA, and the impact is permanent. Further, we find contrasting evidence for NG (positive) and SA (negative) in respect of the response of the real output of these countries to US monetary policy shocks. This tends to support evidence from Hajek and Horvath [15]. It is, however, in contrast with Dées

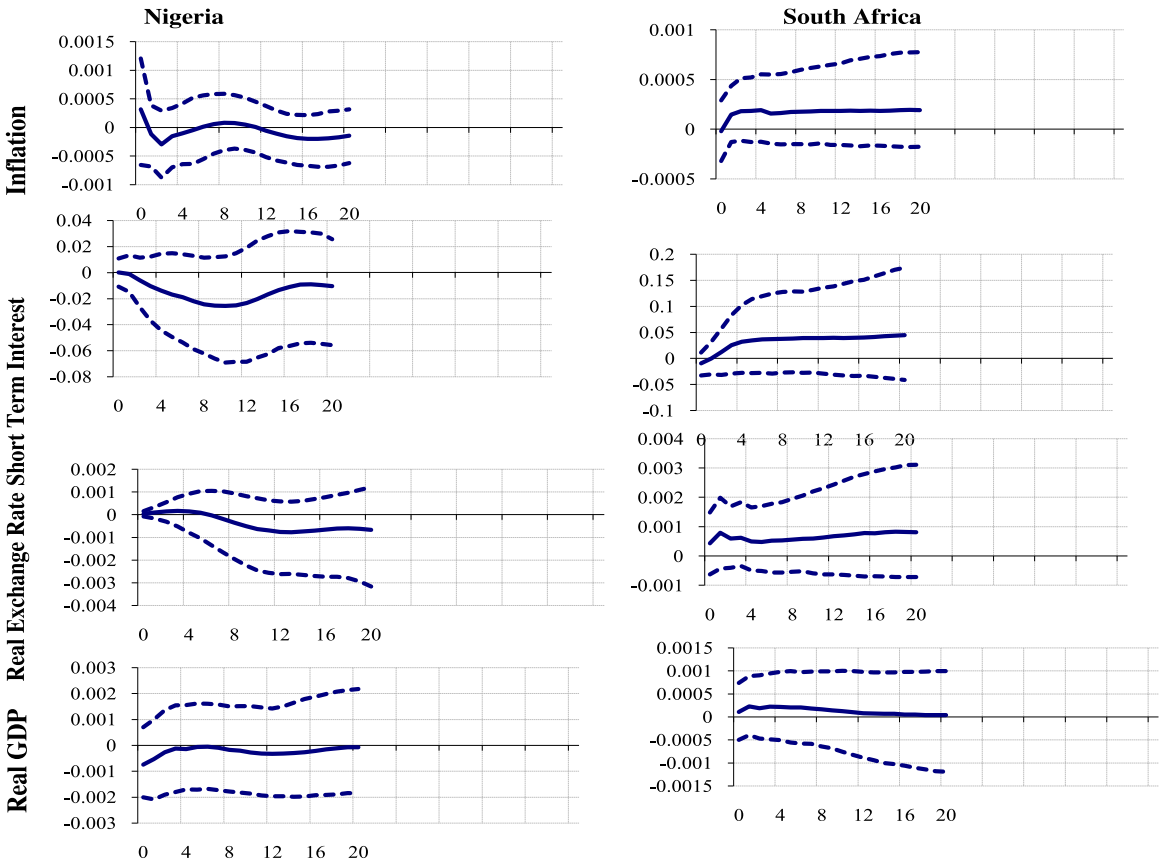

Fig. 2. Impulse Responses of macroeconomic variables in Nigeria and South Africa to EU monetary policy shock.

and Galesi [10] and Walerych and Wesołowski [41], which suggests that US monetary policy shock boosts macroeconomic activity worldwide.

The impulse responses of NG and SA to EU monetary policy shocks are presented in Fig. 2. The inflation rate in Nigeria responds negatively to expansionary monetary policy in the EU. On the contrary, the inflation rate in SA responds positively to monetary expansion in the EU. The response of both inflation and short-term interest rate in SA rises in the first quarter, peaks in the fourth quarter, and stabilises over the longer forecast horizon. Hence, a surprise increase in the EU interest rate is followed by a decline in interest rate in Nigeria and a higher interest in South Africa. Initially, the naira exchange rate shows appreciation from the first quarter through the sixth before depreciating in the long term. In SA, a similar initial appreciation is observed, but short-lived – lasting for only two quarters before depreciating. The response of NG's real output to EU monetary policy remained negative over the long horizon. Similarly, real output in SA reported a sharp rise from the initial negative response and thereafter declines over the horizon.

The responses to Chinese monetary policy shocks are presented in Fig. 3. Prices in NG and SA appear to behave similarly to monetary policy shocks from China at varying time lags. Both countries show initial positive price reactions which peaked in the third and second quarters for Nigeria and SA respectively after which they witness a decline. Short term interest rate in Nigeria and South Africa responds positively to monetary policy shock from China with visibly permanent effect on both countries. This is similar to the result obtained by Ter Ellen et al. [40] in respect of Norway and Sweden. Also, real exchange rate in Nigeria and SA responds the same way to China's monetary policy shock, with SA's response having higher magnitude than NG's. While the shock appears to be short-lived in Nigeria, it is permanent in SA. Expansionary monetary policy in China leads to depreciation of the Nigerian Naira and the South African Rand. This can be attributed to possible demand pressure on the dollar as local consumers increase their consumption of Chinese goods and services which have now become cheaper. The impacts of China's monetary policy shocks on real output differ between the countries, with a positive reaction in SA and a negative in the case of NG. We can link the results with the argument that increased output in China due to its expansionary monetary policy raise demand for inputs higher in SA than Nigeria.

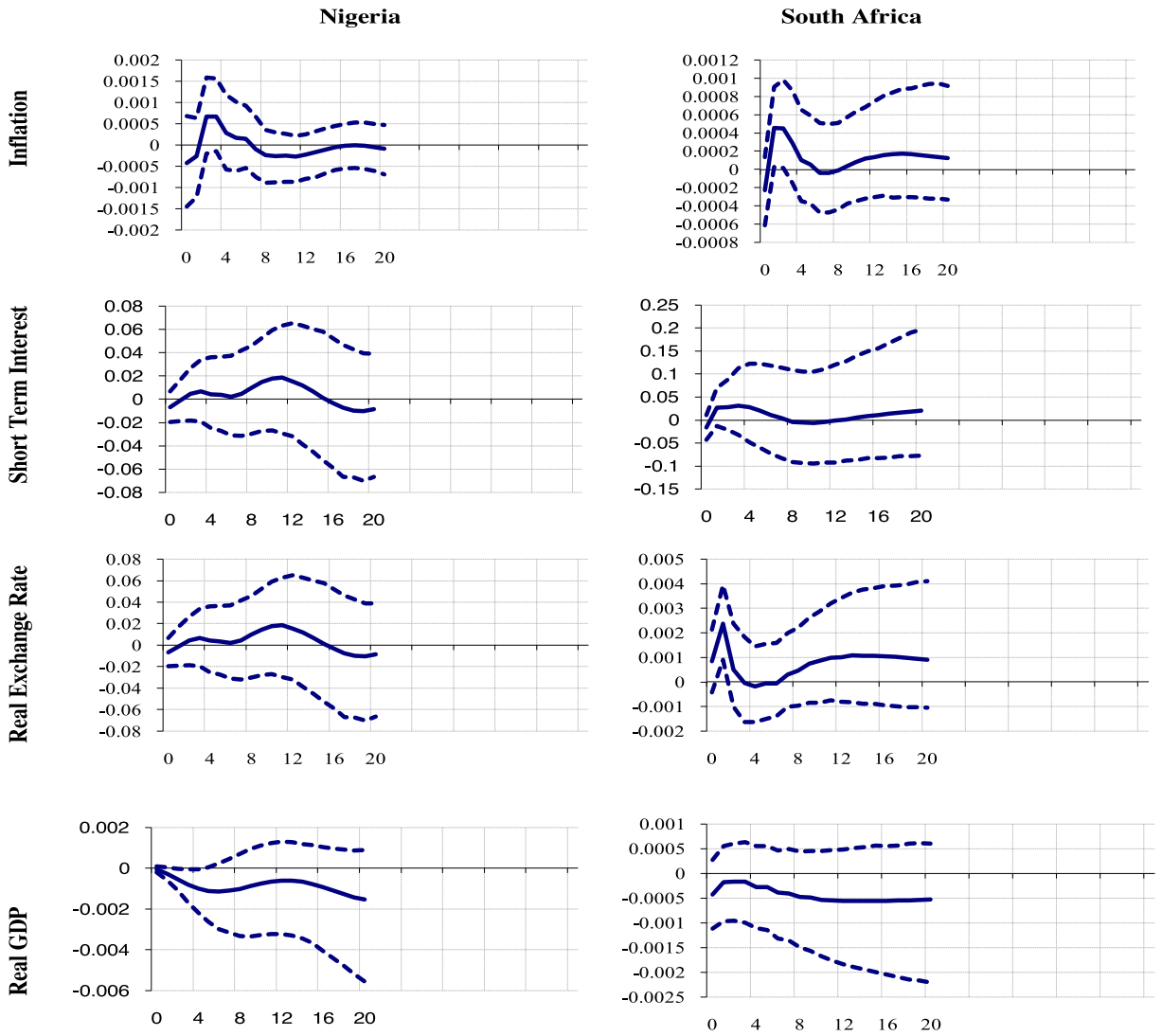

Fig. 3. Impulse responses of macroeconomic variables in Nigeria and South Africa to monetary policy shock from China.

Conclusion

This study examines the vulnerability of the two largest emerging economies in Sub-Saharan Africa (SSA) – Nigeria and South Africa to international monetary policy shocks from large open economies – China, Europe and the USA. With the increasing ties between the former and the latter, the possibility of shock spillovers is cannot be dispelled. To achieve our main objective, we construct a GVAR model and update the common GVAR database to accommodate the selected countries in SSA. Consequently, the impulse response functions are used to analyse the response of these emerging economies to monetary policy shocks due to the considered large open economies.

On the whole, four findings can be discerned from the various analyses conducted in this study. First, there is a negative response of inflation in Nigeria to monetary policy (MP) shock in the US and EU. This indicates that MP tightening in the US and EU could moderate prices in Nigeria, whereas expansionary MP is capable of being inflationary in the country. The case of South Africa is different, as the response of the inflation rate of the country to international MP shocks appears positive. This implies that MP tightening, for instance in the US, EU, and China is bound to be inflationary in South Africa. This can be largely attributed to the South Africa's strong production base, such that MP tightening in these countries could enhance the demand for South Africa's goods and services relative to their foreign counterparts leading to a rise in prices.

Second, the MP decisions of the US and China played a critical role in the adjustment of the domestic interest rate in both Nigeria and South Africa, although for a short time period. However, shock to EU MP does not seem to have significant effect on the short-term interest rate of both Nigeria and South Africa. This implies that MP decisions in China and the

US have higher influence of the interest rates in Nigeria and South Africa compared to that of the EU. Hence the EU MP shock can be said to be less relevant to the emerging economies in SSA. Third, international MP shock emanating from the selected source countries seems to affect the value of the domestic currencies of both emerging SSA countries, although far more prolonged for Nigeria than South Africa. Specifically, while the exchange rate of both Nigeria and South Africa responds positively to monetary shocks emerging from the sampled global shocks originating countries, it is sharper for South Africa, reflecting the country's ability to curb excessive imports and where necessary concentrate on factor inputs that are used to generate further production.

Lastly, the emerging SSA countries respond differently to shocks from the three selected sources of global shocks. Particularly, the impact of China's monetary policy shock on real output is positive for SA and negative for the case of NG. In respect of the EU monetary policy, the response of the real output for both NG and SA is negative over long horizon. Meanwhile, there is contrasting evidence for NG (positive) and SA (negative) with respect of the response of the real output to the monetary policy shock emanating from the US.

In all, we strengthen the literature on the susceptibility of emerging economies to global shocks, with particular highlight of Nigeria and South Africa as choice investment hubs in Africa. For future research purpose, an expanded GVAR database that accommodates more emerging economies in Africa including the Northern sub-region of the continent will offer a wider scope and greater acceptability for possible generalisation of empirical findings.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.sciaf.2021.e00976.

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